Measurement Radon Concentration in the Iraqi Building Materials: Brick Samples

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ABSTRACT

Radon gas is a major cause of lung cancer. This is because, after breathing it, decay by emitting alpha particles, which works like a shot in the targeting of the bronchi and cause lung cancer. The current paper aims to measure the concentration of radon gas in bricks used solid-state nuclear track detector CR – 39. Eighteen different models of bricks from the local plants, which are used in the construction of Iraqi houses, were collected. The results showed that the highest radon concentration is in the sample manufactured in Union plant with 162.39 Bq/m³, while the smallest value is in the Al-Naseem plant with concentration 55.90 Bq/m³. Current results indicate that the models bricks contain concentrations of radon gas within the internationally permissible limits.

1. INTRODUCTION

Radon gas represents a noble gas and it is heavier than air seven times and a half, leading to his presence at the bottom always, a mixed almost uniformly with the indoor air of homes. The concentration of radon in homes is generally higher than the 2 to 10 times it abroad, so it is often neglected radon exposure outside the home [1]. The main sources of radon in the middle, the outer two of soil and water, and produces about 80% of radon emanating from the outside to the middle, the upper layer of the earth. And consequently, the presence of Radium-226 and then Uranium-238 is the reason for the presence of radon in the soil and then concentrations vary from one place to another according to the geological nature and often concentrated in granitic rocks and phosphatic. There is a statistical relationship to the occurrence of earthquakes with radon concentration in the soil as it was found that this matter could occur in rocks with content 100 ppm of uranium hundreds of meters in depth [2, 3]. Moreover, the building materials which made from the soil and rocks, such as cement and bricks containing radioactive material with a natural origin such as uranium and radium and thus generate radon. The permeability of these materials is sufficient to set off the radon generated to the center, including the outer [4]. The other building materials such as wood, it contains a very low amount of radium. Found that the rate of issuance of radon varies with environmental conditions, mainly humidity and pressure. This is due to the effect of humidity and pressure in the rebound atom of radon radiation resulting from the disintegration of radium [5]. There are many methods for measuring the concentration of radon in environmental models. The impact of solid-state nuclear track detectors is one of the important of these methods [6, 7]. Solid-state nuclear track detectors (SSNTDs) were used in the measurement of different environmental applications and measuring radioactivity of environmental models such as bricks. However, SSNTDs have high sensitivity and efficiency for recording the tracks of charged particles such as; protons, alpha particles and fission fragments. Radon gas from environmental contaminants cause serious health problems and one must give high attention to the problem of radon gas (222Rn) and thoron gas (220Rn) pollutions. The great danger resulting from the exposure of these isotopes through alpha particles emitted, which has demonstrated the relationship between exposures to the divorced alpha particles with the occurrence of lung cancer. In this study, measurement of radon concentration (222Rn) in eighteen bricks models that collected from factories in Baghdad, the capital of Iraq, by SSNTDs technique with CR-39 detector.

2. Methodology

Samples were collected from eighteen brick factories distributed in Baghdad, as shown in Table 1. Each sample is taken from each brick were left in the laboratory for one month to get radioactive equilibrium, and then milled by a hammer. A sampled brick weight (about 30 g) is put into a container of plastic has length about 7 cm and a diameter 5 cm, then the CR-39 detector putted in the bottom of the lid from the inside. This geometry helps us to prevent the Thoron gas (220Rn) to reach the detector, where the half-life of this gas is very short (about 56s), so it fades before reaching the detector. The dosimetry of radon is shown in Figure 1. CR-39 detector was calibrated by putting it in the chamber contents standard Radium (226Ra source), which emits radon gas. The activity of the 226Ra source is 5 μci ( = 18.5 × 10⁴ Bq). After irradiation for two months (by the brick samples), CR – 39 detectors are chemically etched in the 6.25N NaOH solution using water bath at 70°C for 7 h to reveal the tracks [8]. Then the tracks are estimated by optical microscope.
The relationship between the tracks density and the exposure to radon (Bq.m$^{-3}$/days) illustrated in Figure 2 and the slope can be given as:

$$\text{Slope} = \frac{T_s}{E_s}$$

(1)

where $T_s$ is the number of tracks density in the standard (calibration) detector (number of tracks per mm$^2$), and $E_s$ is the radon exposure (Bq.m$^{-3}$) from the standard $^{226}\text{Ra}$ source. The calculated concentrations of radon gas ($C_x$) in brick samples can be estimated from the relationship:

$$C_x = \frac{T_x}{\text{Slope}}$$

(2)

where $T_x$ is tracks density in the brick samples.

3. RESULTS AND DISCUSSION

The concentration of uranium in the soil is located within the rear surface of 1-2 cm and this leads to the presence of the $^{226}\text{Ra}$ isotope in the soil, including that radon comes directly from the decay of $^{226}\text{Ra}$. However, soils represent the crud martial in the most of the construction materials. Therefore, it is important to measure the concentration of radon gas in building materials, especially bricks because it is used in the construction of houses and the population exposed to radon gas directly for long period of time.

Table (1) and figure (3) shows the results of measurement of the concentrations of radon ($^{222}\text{Rn}$) in the studied bricks samples. Moreover, the radon gas was found in all studied samples for bricks as shown in Table 1, but with different concentrations. The results illustrated that the highest concentration was found in the samples made in Union factory with 162.39 Bq/m$^3$, which is due to the agriculture soil nature used in this factory which contains a fertilizer, while the lowest concentration was found in the sample of bricks of the Al-Naseem factory with 55.90 Bq/m$^3$. However, the founded concentrations of radon gas are within the internationally permissible limits such as ICRP limitations (200 Bq/m$^3$) [9].

![Figure 1 Schematic diagram of the sealed-cup dosimetry](image)

<table>
<thead>
<tr>
<th>Samples</th>
<th>Factories Name</th>
<th>Tracks density (No. of tracks/mm$^2$)</th>
<th>Concentrations of Radon Gas (Bq/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Al-Abrar</td>
<td>1.54</td>
<td>85.30</td>
</tr>
<tr>
<td>2</td>
<td>Ahmed abu al-jamur</td>
<td>1.39</td>
<td>77.01</td>
</tr>
<tr>
<td>3</td>
<td>Union</td>
<td>2.94</td>
<td>162.39</td>
</tr>
<tr>
<td>4</td>
<td>Al-murtada</td>
<td>1.79</td>
<td>98.73</td>
</tr>
<tr>
<td>5</td>
<td>Adnan</td>
<td>2.00</td>
<td>110.67</td>
</tr>
<tr>
<td>6</td>
<td>Brothers</td>
<td>1.84</td>
<td>101.99</td>
</tr>
<tr>
<td>7</td>
<td>Al-Afraan</td>
<td>2.63</td>
<td>145.31</td>
</tr>
<tr>
<td>8</td>
<td>Haj Ali</td>
<td>2.26</td>
<td>124.76</td>
</tr>
<tr>
<td>9</td>
<td>Al-Naseem</td>
<td>1.01</td>
<td>55.90</td>
</tr>
<tr>
<td>10</td>
<td>Al-Naba</td>
<td>1.28</td>
<td>70.60</td>
</tr>
<tr>
<td>11</td>
<td>Al-Najaat</td>
<td>2.42</td>
<td>133.82</td>
</tr>
</tbody>
</table>
12 Al-Sheek 1.94 107.24
13 Al-Halaney 1.48 81.93
14 Haj abu Amad 2.31 127.80
15 Al-Mansor 2.13 117.91
16 Baladrose 2.56 141.67
17 Al-Barakat 1.20 66.18
18 Al-Tasahul 2.57 142.16

4. CONCLUSIONS
The radon concentrations were estimated in brick samples, which represent the main issue of the building materials in Iraqi buildings using CR-39 detectors. The radon levels were found lower than the recommended ICRP action levels. All results show that no action is required to reduce radon levels inside the buildings which were built by these bricks.

REFERENCE
